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AGE AND LENGTH STUDIES AND HARVEST SURVEYS OF ARCTIC GRAYLING ON THE SEWARD PENINSULA, 1988[1]

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

A total of 990 Arctic grayling *Thymallus arcticus* was captured by beach seine and hook and line in the Nome, Snake, Sinuk, Solomon, Eldorado, Pilgrim, Kuzitrin, Niukluk, and Fish Rivers and Boston Creek on the Seward Peninsula in 1988. Arctic grayling were sampled for length and age; fish greater than 150 millimeters fork length were tagged. Incidentally caught Dolly Varden/Arctic char *Salvelinus alpinus* were tagged and measured for length. Estimates of mean length at age were achieved at the desired level of precision for most age classes sampled. Mean length at age varied by stream. Younger age classes (ages 0 to 2 years) were underrepresented in the catch. Variation in estimating scale age among two replicate counts by one reader was not significant. Length composition of the catch significantly differed by gear type, with beach seines selecting for fish of smaller lengths (less than 250 millimeters fork length). Growth characteristics varied among stocks. Theoretical maximum length estimates were the greatest for Arctic grayling from the Snake, Kuzitrin, and Pilgrim Rivers. The Brody growth coefficient estimate was greatest for Arctic grayling from the Fish River.

A total of 32 angler interviews was conducted on the Seward Peninsula in 1988. This number was insufficient to estimate Arctic grayling and Dolly Varden/Arctic char catch-per-hour by stream at the desired level of precision. However, interviews provided information on harvest strategy of Arctic grayling by sport and subsistence fishermen, angler demographics and opinions regarding regulation changes. It is not deemed cost-effective to conduct a creel census for streams on the Seward Peninsula.

KEY WORDS: Arctic grayling, *Thymallus arcticus*, Seward Peninsula, mean length at age, length composition, age composition, gear selectivity, relative stock density, von Bertalanffy growth model, beach seine, hook and line.

INTRODUCTION

The Seward Peninsula supports the second largest recreational fishery in the Arctic-Yukon-Kuskokwim (AYK) region. From 1983 to 1987, an average of 18,764 angler-days were fished per year on the Seward Peninsula. This represents 9.4% of the AYK angler-day average during the same time period (Mills 1988). The reported freshwater sport fish harvest on the Seward Peninsula consists primarily of Dolly Varden/Arctic char *Salvelinus alpinus*, Arctic grayling *Thymallus arcticus*, coho, pink, chum and chinook salmon *Oncorhynchus* spp., northern pike *Esox lucius*, and whitefish *Coregonus* spp. Of the 18,722 fish harvested by recreational anglers in 1987 on the Seward Peninsula, 4,600 (24.6%) were Arctic grayling (Mills 1988).

Arctic grayling on the Seward Peninsula can range up to 559 mm (about 22 in) in length and over 1.8 kg (4 lbs) in weight. The Seward Peninsula is the only area in Alaska, other than the Bristol Bay area, that consistently produces trophy-size Arctic grayling. Of 102 Arctic grayling registered with the Alaska Department of Fish and Game (ADF&G) Trophy Fish Program from 1967 to 1987, 25 (24.5%) were from the Seward Peninsula (Alaska Department of Fish and Game 1987). The average total length of trophy Arctic grayling from the Seward Peninsula was 526 mm (20.7 in) and average weight was 1.5 kg (3.3 lbs).

While the Seward Peninsula cannot be reached by road, approximately 7,800 residents in the Nome census area (Alaska Department of Labor 1987) travel on roughly 418 km (260 mi) of state-maintained gravel roads from May through September. These roads originate in Nome and traverse the Seward Peninsula in three main directions: the Kougarok Road extending to the north, the Teller Road to the west, and the Council Road to the east (Figure 1).

Road accessibility to clear-water streams containing trophy-size Arctic grayling has contributed to increasing sport fishing pressure in streams near Nome (Alt 1978, 1979, 1980). Additionally, increasing subsistence harvest of Arctic grayling in a few streams has raised concern regarding stock status among local anglers. Input from local anglers and ADF&G staff in Nome indicated that abundance of larger-size Arctic grayling appeared to be declining in streams popular among recreational anglers. Based on this input, regulations were promulgated in 1988 to restrict harvest of Arctic grayling on the Seward Peninsula to five per day, five in possession, with only one over 380 mm (15 in). Previous regulations provided for a combined bag limit (Arctic grayling and Dolly Varden/Arctic char) of 15 per day, 30 in possession, with only three fish per day over 20 in.

Increasing publicity of Seward Peninsula angling opportunities and public attention toward Arctic grayling stocks prompted initiation of research on Arctic grayling stock status and harvest in 1988. Prior to this study, little information was available regarding Arctic grayling stock abundance on the Seward Peninsula or level of harvest and amount of fishing effort in specific waters. The first studies conducted by the ADF&G on the basic life history and angler utilization of fish on the Seward Peninsula began in July 1977 and continued through September 1979. During this time, nine streams were surveyed for Arctic grayling, and 147 fish were sampled for age, length and weight. Angler counts were conducted periodically on 15 different streams

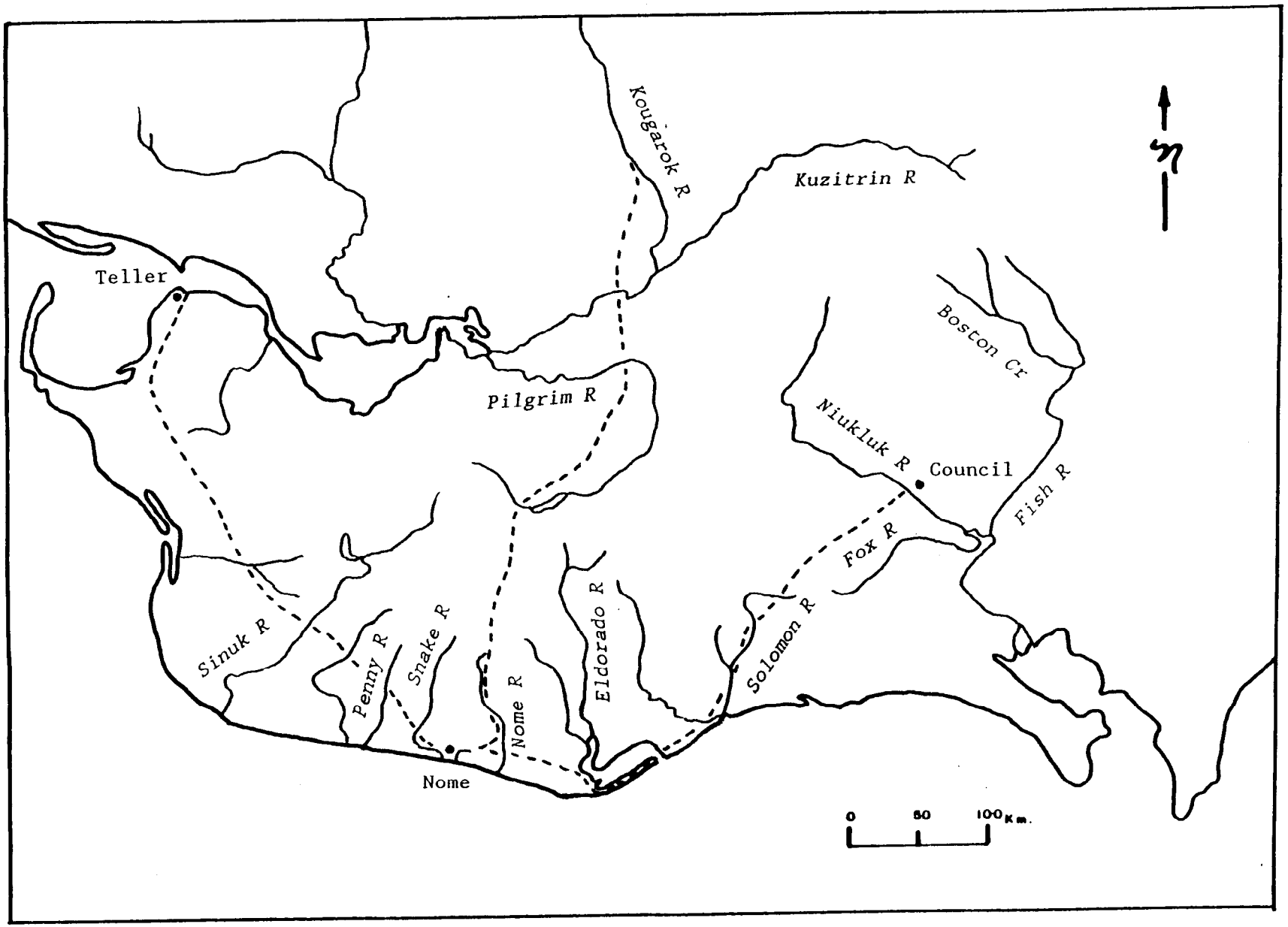

Figure 1. Streams and roads (dashed lines) of the Seward Peninsula.

(Alt 1978, 1979, 1980), however, number of anglers counted was not reported by the length of time observed, so only a qualitative assessment of harvest pressure was possible. Between 1979 and 1984, 88 Arctic grayling from the Fish/Niukluk Rivers were sampled for age, length and weight (Alt 1986). These early studies provided preliminary information such as access routes, river bed characteristics, water quality (ie. temperature and dissolved oxygen), and impressions on migration and spawning times for Arctic grayling in selected rivers.

This project was initiated in June 1988 to survey Arctic grayling stocks supporting the greatest harvest pressure on the Seward Peninsula. Long-term goals of the project are to:

1. identify those Arctic grayling stocks that can produce trophy fisheries, large sustainable yields, or presently produce large harvests in sport fisheries; and

2. develop regulations that will insure continued sustained yields from the fisheries for Arctic grayling without undue disruption to the sport-fishing public.

Project objectives for 1988 were to:

1. estimate mean fork length by age of Arctic grayling in the Nome, Snake, Sinuk, Eldorado, Niukluk, Fish, Kuzitrin, Pilgrim, and Kougarok Rivers, and Cripple and Boston Creeks; and

2. estimate the average catch and harvest per unit of effort of Arctic grayling and Dolly Varden/Arctic char by anglers fishing the streams mentioned above.

METHODS

Fish Capture

Field work began on 28 June and continued through 13 August 1988. Waters sampled for Arctic grayling were the Nome, Snake, Sinuk, Pilgrim, Kuzitrin, Solomon, Eldorado, Niukluk, and Fish Rivers and Boston Creek. Although Cripple Creek and the Kougarok River were originally scheduled for sampling, extremely low water conditions throughout the summer precluded a survey by raft or boat of Cripple Creek. The Kougarok River was not sampled because extended sampling effort of the Fish/Niukluk River system assumed a higher priority in the time available for field work.

Rivers were accessed with either a 3.7 m (12 ft) Avon inflatable raft with an outboard motor or a 5.5 m (18 ft) river skiff equipped with an outboard jet. Fish were captured with hook and line and a 30.5 x 2.4 m (100 x 8 ft) seine net with 1.3 cm (0.5 in) stretched nylon mesh, undyed. Hook and line gear was used in swift riffle areas, in small side channels, and in sections strewn with debris or large boulders. The beach seine was usually deployed in sections with slow to moderate current.

Age and Length

All Arctic grayling and Dolly Varden/Arctic char captured were measured to the nearest mm of fork length (FL). Arctic grayling greater than 150 mm FL and adult Dolly Varden/Arctic char were tagged with sequentially-numbered Floy FD-67 internal anchor tags inserted among the interneural rays of the dorsal fin. The adipose fin was removed to prevent double sampling of recaptured fish that had shed tags. Data were recorded on standard Sport Fish Division tagging-length forms (version 1.0.)

A sample of 600 fish per stream was deemed sufficient to meet criteria for estimating mean length at age for any age group comprising at least 2% of the sample (Cochran 1967). These calculations were based on the expectation that the largest standard deviation would be no more than 25 mm FL; the largest standard deviation observed for age groups of Arctic grayling in the Tanana River drainage (Clark and Ridder 1987).

Scale samples were taken from Arctic grayling from an area above the lateral line and below the posterior insertion of the dorsal fin. Sagittal otoliths were removed from eight fish inadvertently killed during capture efforts, but sample size was insufficient to use otoliths to estimate fish ages. Scales were cleaned with warm water and detergent. Two scales from each fish were mounted on gum cards, and acetate impressions were made (30 seconds at 7,000 kg/cm^2, at a temperature of 100° C). Ages were determined by counting all annuli with scale impressions magnified on a microfiche reader. Replicate readings were conducted by systematically resampling every fourth fish.

Harvest Surveys

All anglers encountered were interviewed to obtain information on harvest, fishing effort, demography, and opinions regarding stock management.

Data recorded during these interviews included:

1. date and time of day;
2. location;
3. number of anglers fishing;
4. hours spent fishing;
5. number of fish by species kept and released;
6. demographic information; and,
7. gear type; and,
8. target species.

Questions comprising the opinion portion of the survey were:

1. How would you rate the fishing here this year for Arctic grayling? (a) better, (b) worse, (c) same, (d) no opinion, or (e) did not fish here last year;

2. The Board of Fisheries enacted new regulations to improve sport fishing for Arctic grayling in this area by decreasing the bag/possession limit to five Arctic grayling, and allowing only one Arctic grayling over 15 in to be kept. Do you think the new regulations are: (a) a good idea, (b) too restrictive, (c) too liberal, (d) do not live here, or (e) no opinion; and,

3. What is the minimum size Arctic grayling you would keep? (a) any size, (b) over 6 in, (c) over 10 in, (d) over 15 in, (e) 18 to 23 in only, or (f) no opinion.

All harvest survey and angler interview data were analyzed as outlined in Baker (1989).

Data Analysis

The sampling standard deviation (SSD) was used as a measure of variability in scale age estimates, and was calculated as:

$$(1) \quad SSD = \left[\frac{\sum_{N} (x_{jk} - x_k)^2}{(N - 1)} \right]^{1/2}$$

where:

x_{jk} = the jth replicate for fish k;

x_k = the mean estimate for fish k; and,

N = the sample size of 212 replicate readings.

The Wilcoxon signed rank test was used to test for differences in mean age estimates among replicate scale readings (Zar 1984). Data for both replicates were symmetrical about the median (median = six years; interquartile range = five to seven years).

Length selectivity of capture gear was examined with the Kolmogorov-Smirnov test. Age class composition estimates are affected by size-specific vulnerability, especially among younger fish in a sample (Ricker 1975). With detection of significant bias, adjustments in age class composition estimates can be made if capture probabilities from abundance estimates are known (Clark and Ridder 1988). Since abundance estimates were not an objective of this project in 1988, age and length composition estimates were unadjusted.

Mean length at age was calculated as the arithmetic mean of all fish lengths assigned the same age. Variances were calculated with the squared deviations

from the mean (standard variance formula). Standard errors of the mean (SE) were calculated as the square root of the variance divided by the sample size.

The proportion of Arctic grayling in each age class was estimated as:

$$(2)\ \hat{p}_i = y_i/n;$$

where:

y_i = the number of Arctic grayling of age i; and,

n = the number sampled.

The unbiased variance estimate of this proportion was:

$$(3)\ V[\hat{p}_i] = \frac{\hat{p}_i(1 - \hat{p}_i)}{n - 1}$$

Equations (2) and (3) were used to estimate Relative Stock Density (RSD) indices (Gablehouse 1984). The RSD categories for Arctic grayling are: Stock (150 to 269 mm FL); Quality (270 to 339 mm FL); Preferred (340 to 449 mm FL); Memorable (450 to 559 mm FL); and Trophy (greater than 559 mm FL).

Growth characteristics by stock were estimated with length at age data. The von Bertalanffy growth model (Ricker 1975) was chosen to calculate absolute growth (L_t) at ages 1 through 12 years:

$$(4)\ L_t = L\infty(1-e^{-K(t-to)});$$

where:

$L\infty$ = the theoretical maximum length ($L\infty$);

K = the Brody growth coefficient; and,

t_o = the theoretical length at age 0.

These parameters were fitted by nonlinear regression with the Marquardt Compromise (Marquardt 1963). The range of parameter values chosen for iteration by the model were $L\infty$: 300 to 600 mm by 100 mm increments; K: 0 to 0.4 by 0.1 increments; and t_o: -2.0 to 2.0 mm by 0.5 mm increments. A correlation matrix of the parameters was generated.

Total mean catch per unit effort (CPUE) by species for all streams was estimated as:

$$(5)\quad \text{Total mean CPUE} = \frac{\sum_{t} (a_{st} \times b_{st})}{T};$$

where:

a_{st} = the number of anglers interviewed fishing for species s on stream t;

b_{st} = the mean CPUE for that species on stream t; and,

T = the total number of anglers interviewed on the Seward Peninsula targeting for species s. Harvest per unit effort (HPUE) was estimated with equation (5) with the number of fish harvested substituted for the catch.

RESULTS

Age and Length

A total of 887 Arctic grayling was tagged from 10 rivers. The majority of tagged fish were captured from the Niukluk and Kuzitrin Rivers (280 and 157 fish, respectively; Appendix Table 1). The greatest CPUE (8.5 fish per set) during seining occurred on the Niukluk River (Appendix Table 1).

Variation in estimating scale age among replicate counts was less than one year (SSD = 0.72 years). The mean age estimate for the first reading was 6.28 years (SE = 0.13) and for the second reading was 6.39 years (SE = 0.10). No significant differences ($\alpha = 0.05$) were detected in mean age estimates among replicates with the Wilcoxon signed rank test ($Z_{.05(2)} = 1.37$, $P > 0.17$).

Length composition of the catch significantly differed by gear type (two sample Kolmogorov-Smirnov test, $D_{.05,2,691} = 0.17$, $P = 0.00$). The beach seine selected for fish of smaller lengths (less than 250 mm FL) than hook and line gear (Figure 2). Arctic grayling greater than 250 mm FL were more readily captured with hook and line than with the beach seine.

The greatest proportion of young-of-the-year and one-year-old Arctic grayling were sampled in the Snake and Kuzitrin Rivers. Trace numbers of young Arctic grayling were found in the Fish and Niukluk Rivers (Table 1). Virtually no age 2 Arctic grayling were found, except for a few in the Kuzitrin River. Capture rates of age 3 fish were substantially greater than those for age 2 fish. Age 3 fish were found in all streams except the Pilgrim and Fish Rivers and Boston Creek. The youngest year class sampled in Boston Creek was age 6 (Table 1). Age 10 and older fish were found in all streams except the Fish and Eldorado Rivers. The oldest fish (age 12) were found in the Pilgrim River (Table 1).

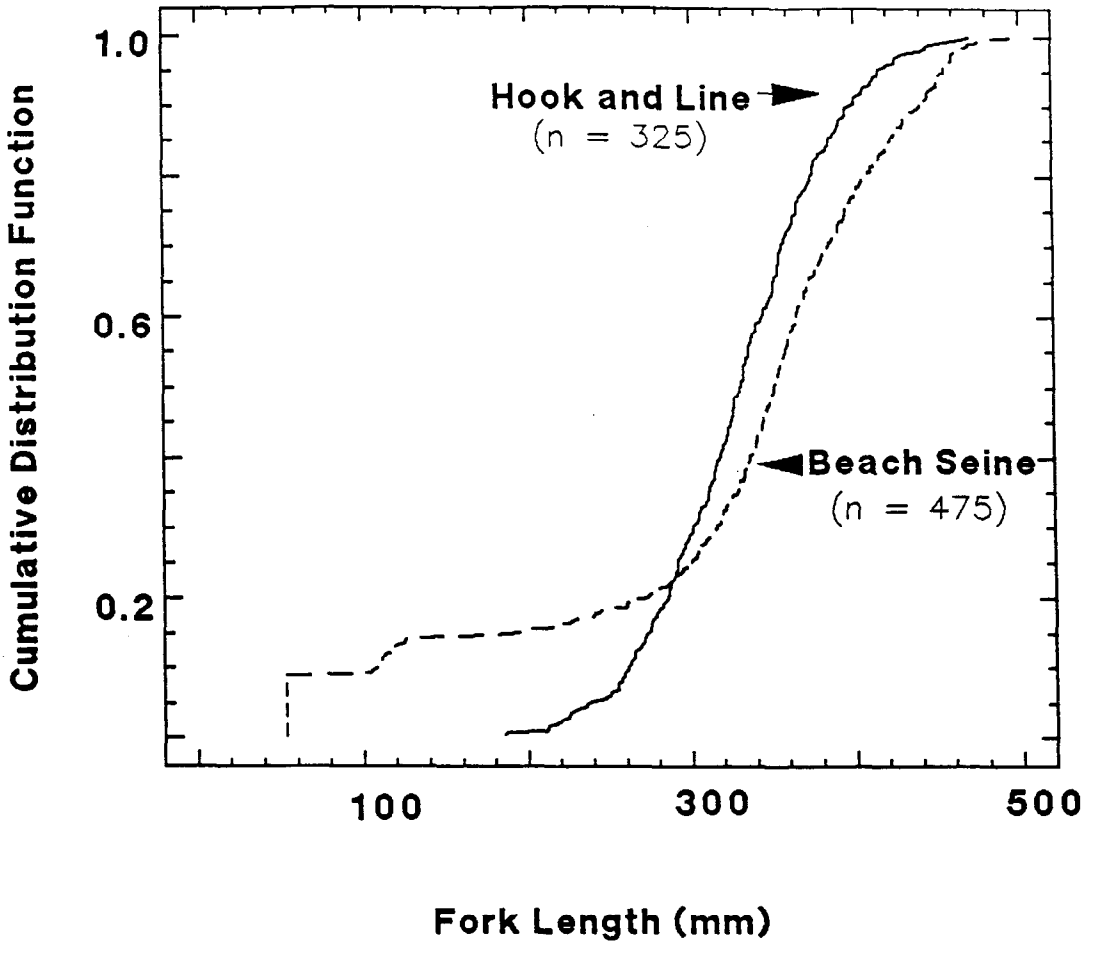

Figure 2. Length selectivity of Arctic grayling by beach seine (net) and hook and line gear, Seward Peninsula, 1988.

Table 1. Unadjusted estimates[1] of proportional contribution of each age class, mean fork length (mm) at age, and standard errors for Arctic grayling captured by beach seine and hook and line fishing, by river on the Seward Peninsula, 28 June to 13 August, 1988.

	Age													
River	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Nome														
n[2]	0	0	0	12	2	2	9	7	3	2	2	0	0	39
p[3]	0	0	0	0.309	0.051	0.051	0.231	0.179	0.077	0.051	0.051	0	0	1.000
SE[4]	0	0	0	0.075	0.036	0.036	0.068	0.062	0.043	0.036	0.036	0	0	---
mean[5]	0	0	0	238	273	309	393	436	457	445	449	0	0	353
SE[6]	0	0	0	4	30	27	9	8	6	9	6	0	0	15
Boston														
n	0	0	0	0	0	0	15	21	15	7	6	0	0	64
p	0	0	0	0	0	0	0.234	0.329	0.234	0.109	0.094	0	0	1.000
SE	0	0	0	0	0	0	0.053	0.059	0.053	0.039	0.037	0	0	---
mean	0	0	0	0	0	0	375	378	424	448	443	0	0	402
SE	0	0	0	0	0	0	5	5	5	8	10	0	0	5
Fish														
n	0	2	0	0	0	24	27	6	1	1	0	0	0	61
p	0	0.033	0	0	0	0.393	0.444	0.098	0.016	0.016	0	0	0	1.000
SE	0	0.023	0	0	0	0.063	0.064	0.038	0.016	0.016	0	0	0	---
mean	0	115	0	0	0	350	351	375	429	425	0	0	0	348
SE	0	2	0	0	0	5	4	8	--	--	0	0	0	6
Snake														
n	30	8	0	4	6	21	29	19	22	7	5	0	0	151
p	0.199	0.053	0	0.026	0.040	0.139	0.192	0.126	0.146	0.046	0.033	0	0	1.000
SE	0.033	0.018	0	0.013	0.016	0.028	0.032	0.027	0.029	0.017	0.015	0	0	---
mean	53[7]	120	0	266	278	323	353	382	433	441	458	0	0	295
SE	2[7]	4	0	15	13	6	7	7	4	8	11	0	0	12

-continued-

Table 1. Unadjusted estimates[1] of proportional contribution of each age class, mean fork length (mm) at age, and standard errors for Arctic grayling captured by beach seine and hook and line fishing, by river, 28 June to 13 August, 1988 (continued).

	Age													
River	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
Kuzitrin														
n[2]	30	3	4	11	17	25	29	30	23	1	1	0	0	174
p[3]	0.172	0.017	0.023	0.063	0.098	0.144	0.167	0.172	0.132	0.006	0.006	0	0	1.000
SE[4]	0.029	0.010	0.011	0.019	0.023	0.027	0.028	0.029	0.026	0.006	0.006	0.000	0.000	---
mean[5]	53[7]	124	187	212	240	285	324	352	366	415	415	0	0	261
SE[6]	2[7]	7	7	12	10	10	11	11	10	0	0	0	0	9
Pilgrim														
n	0	0	0	0	2	4	5	9	11	20	20	11	5	87
p	0	0	0	0	0.023	0.046	0.058	0.103	0.126	0.230	0.230	0.126	0.058	1.000
SE	0	0	0	0	0.016	0.023	0.025	0.033	0.036	0.045	0.045	0.036	0.025	---
mean	0	0	0	0	283	325	344	372	400	406	441	443	457	407
SE	0	0	0	0	5	16	13	9	8	7	5	3	6	5
Niukluk														
n	0	1	0	1	2	64	129	43	4	2	1	0	0	247
p	0	0.004	0	0.004	0.008	0.259	0.523	0.174	0.016	0.008	0.004	0	0	1.000
SE	0	0.004	0	0.004	0.006	0.028	0.032	0.024	0.008	0.006	0.004	0	0	---
mean	0	125	0	212	275	321	338	351	386	439	402	0	0	336
SE	0	--	0	--	0	4	2	4	17	5	--	0	0	2
Eldorado														
n	0	0	0	3	15	16	5	5	4	4	0	0	0	52
p	0	0	0	0.058	0.288	0.308	0.096	0.096	0.077	0.077	0	0	0	1.000
SE	0	0	0	0.033	0.063	0.065	0.041	0.041	0.037	0.037	0	0	0	---
mean	0	0	0	263	277	319	318	381	405	436	0	0	0	325
SE	0	0	0	13	4	10	8	14	5	5	0	0	0	8

[1] age composition was not adjusted for bias in length selectivity by gear type.
[2] n = sample size
[3] p = proportion of sampled Arctic grayling
[4] SE = standard error of p.
[5] mean = average fork length (mm) of all sampled Arctic grayling of a given age
[6] SE = standard error of mean fork length
[7] estimate

Mean length at age varied by stream (Table 1). Mean FL of age 3-5 fish from the Snake River was greatest, followed by fish from the Eldorado, Nome, Niukluk and Kuzitrin Rivers (Table 1). For age 6 fish, the smallest mean FL was 318 mm for fish from the Eldorado River, and the greatest mean FL was 393 mm for fish from the Nome River. Mean length for ages 7-10 was greatest in Arctic grayling sampled from the Nome River. Although mean length of fish in the nine and 10 year old age classes was slightly larger in fish sampled from Boston Creek and the Snake River respectively (Table 1). The greatest mean FL for all combined ages was 407 mm, from the Pilgrim River (Table 1).

Length frequency distributions differed by stream. Sample length frequencies composed primarily of larger fish were found in the Pilgrim, Niukluk, and Fish Rivers, and Boston Creek (Figure 3). The sample from Fish River was composed primarily of two length classes. Length frequency distributions of fish sampled from the Nome, Snake, and Kuzitrin Rivers approximated a bimodal shape, in part due to numbers of young-of-the-year and one-year-old fish in the samples (Figure 3).

Preferred size (Gablehouse 1984) Arctic grayling comprised the greatest proportion of the catch in all rivers in which a beach seine was the primary capture gear (Table 2). Preferred sizes comprised the greatest proportion of the hook and line catch in the Snake, Kuzitrin, and Pilgrim Rivers, while quality size fish comprised the greatest proportion of the catch from the Niukluk and Eldorado Rivers (Table 3). The greatest proportion of memorable size Arctic grayling (0.25) were sampled in the Pilgrim River. No trophy size Arctic grayling were captured.

Parameter estimates for the von Bertalanffy growth equation were generated for the Nome, Fish, Snake, Pilgrim, Kuzitrin, and Niukluk Rivers. Non-linear regression models were significant ($P < 0.001$). Iterations failed to converge for the Eldorado River and Boston Creek, probably due to lack of representative ages in the tails of the length frequency distributions. Assessment of parameter estimates indicates that growth characteristics vary among Arctic grayling stocks on the Seward Peninsula.

Theoretical maximum length (L_∞) was greatest for Arctic grayling from the Snake, Kuzitrin, and Pilgrim Rivers (634 mm, SE = 41; 568 mm, SE = 42; 558 mm, SE = 80, respectively), and the least for Arctic grayling from the Fish River (399 mm, SE = 19; Table 4). The Brody growth coefficient (K) was the greatest for Arctic grayling from the Fish River ($K = 0.40$, SE = 0.08) and the least for fish sampled from the Snake, Kuzitrin, and Pilgrim Rivers ($K = 0.12$, SE = 0.01; $K = 0.12$, SE = 0.02; $K = 0.13$, SE = 0.06, respectively). The relationship between L_∞ and K appeared to be inverse.

Variability in growth characteristics among stocks was examined for Arctic grayling in rivers from similar geographic locations. Assuming that non-genetic factors are the primary influence on growth of Arctic grayling residing in streams of the Seward Peninsula, it was hypothesized that variability in growth would be greater among rivers from different geographic areas than among rivers located in relative proximity to each other, or within the same drainage. Six rivers were grouped into three locations: the Nome and

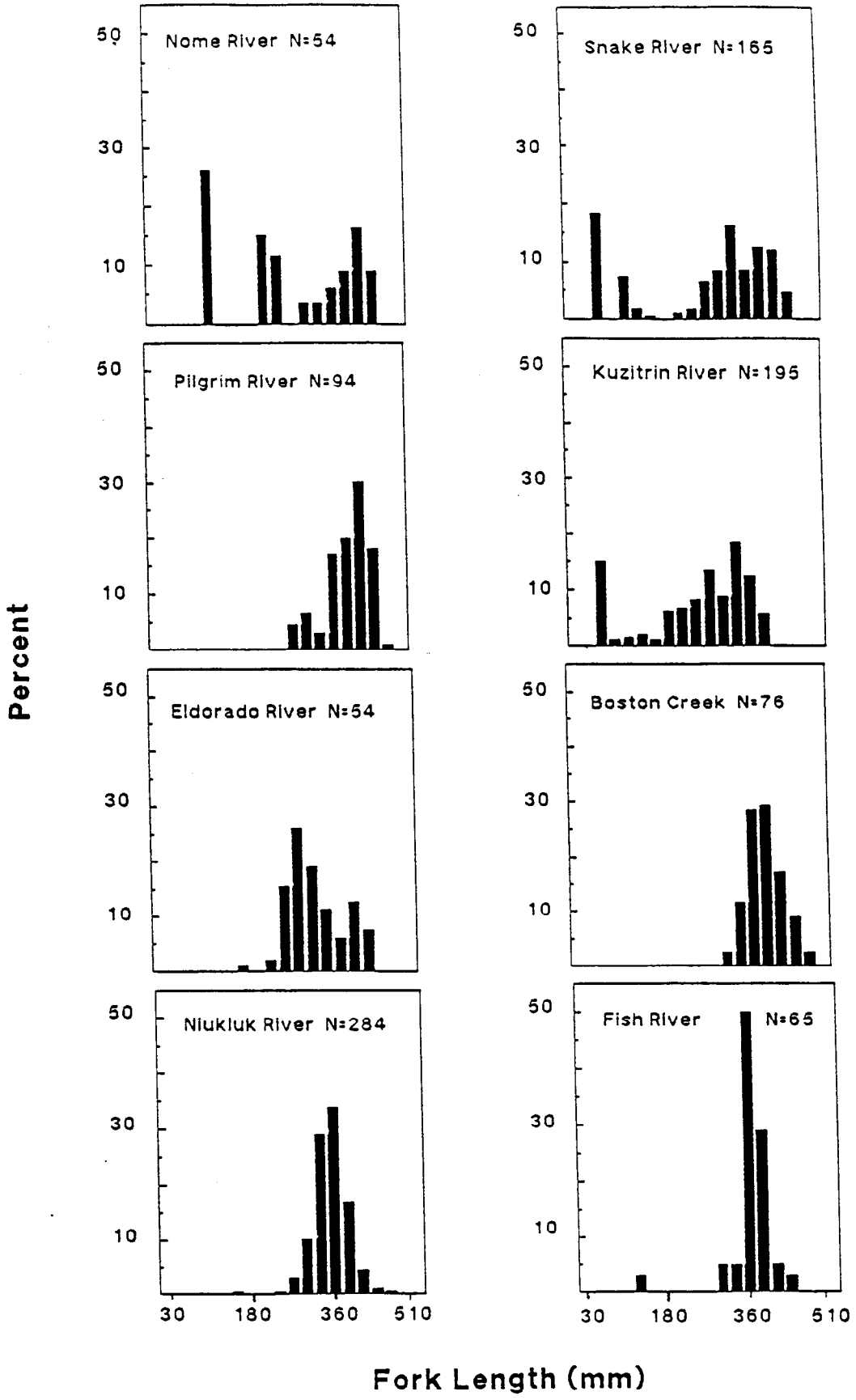

Figure 3. Length frequency distributions (by 30 mm intervals) of Arctic grayling sampled in Seward Peninsula streams, 1988.

Table 2. Relative stock density (RSD) and standard error (SE) for Arctic grayling captured with a beach seine, by river[1], 1988.

River, Date:	RSD[2] Category[3] Stock	Quality	Preferred	Memorable	Trophy
Snake River: 8-25 July					
Sample No.	5	24	55	13	0
RSD[2]	.052	.247	.567	.134	0
SE	.002	.004	.005	.004	0
Kuzitrin River: 3-4 August					
Sample No.	16	21	25	0	0
RSD	.258	.339	.403	0	0
SE	.007	.008	.008	0	0
Pilgrim River: 12-27 July					
Sample No.	0	8	58	16	0
RSD	0	.098	.707	.195	0
SE	0	.004	.006	.005	0
Niukluk River: 29 July - 10 August					
Sample No.	3	77	89	1	0
RSD	.018	.453	.524	.006	0
SE	.001	.003	.003	0	0
Nome River: 2-9 July					
Sample No.	13	4	15	8	0
RSD	.325	.100	.375	.200	0
SE	.012	.008	.012	.010	0
Boston Creek: 26-27 July					
Sample No.	0	3	61	12	0
RSD	0	.039	.803	.158	0
SE	0	.003	.005	.005	0
Fish River: 28 July					
Sample No.	0	12	51	0	0
RSD	0	.190	.810	0	0
SE	0	.006	.006	0	0

[1] Arctic grayling captured in the Eldorado, Sinuk, and Solomon Rivers are not included due to inadequate sample sizes.

[2] RSD calculated directly from the number sampled.

[3] Minimum lengths (FL) for RSD categories are (Gablehouse 1984):

Stock	- 150 mm
Quality	- 270 mm
Preferred	- 340 mm
Memorable	- 450 mm
Trophy	- 560 mm

Table 3. Relative stock density (RSD) and standard error (SE) for Arctic grayling captured with hook and line, by river[1], 1988.

River, Date:	RSD[2] Category[3] Stock	Quality	Preferred	Memorable	Trophy
Snake River: 8-25 July					
Sample No.	1	7	16	0	0
RSD[2]	.042	.292	.667	0	0
SE	.009	.019	.025	0	0
Kuzitrin River: 3-4 August					
Sample No.	26	34	37	0	0
RSD	.268	.351	.381	0	0
SE	.005	.005	.005	0	0
Pilgrim River: 12-27 July					
Sample No.	0	2	7	3	0
RSD	0	.167	.583	.250	0
SE	0	.032	.041	.038	0
Niukluk River: 29 July - 10 August					
Sample No.	5	64	44	0	0
RSD	.044	.566	.389	0	0
SE	.002	.004	.004	0	0
Eldorado River: 5-6 August					
Sample No.	8	28	17	1	0
RSD	.148	.519	.315	.019	0
SE	.007	.009	.009	0	0

[1] Arctic grayling captured from the Nome and Fish Rivers are not included because sampling methods did not include hook and line. Arctic grayling captured from the Sinuk and Solomon Rivers and Boston Creek are not included due to inadequate sample sizes.

[2] RSD calculated directly from the number sampled.

[3] Minimum lengths (FL) for RSD categories are (Gablehouse 1984):

Stock - 150 mm
Quality - 270 mm
Preferred - 340 mm
Memorable - 450 mm
Trophy - 560 mm

Table 4. Parameter estimates (with standard errors in parentheses) and nonlinear correlation coefficients of the von Bertalanffy growth model for Arctic grayling sampled from six rivers on the Seward Peninsula, 1988.

River	Parameter					
	L_∞	K	t_o	Corr(L_∞,K)	Corr(L_∞,t_o)	Corr(K,t_o)
Nome	516 (39)	0.27 (0.07)	0.77 (0.42)	-0.97	-0.86	0.95
Snake	634 (41)	0.12 (0.01)	-0.71 (0.08)	-0.99	-0.59	0.66
Fish	399 (19)	0.40 (0.08)	0.14 (0.23)	-0.97	-0.61	0.74
Niukluk	421 (25)	0.25 (0.06)	-0.47 (0.59)	-0.95	-0.71	0.89
Pilgrim	558 (80)	0.13 (0.06)	-1.65 (1.91)	-0.99	-0.94	0.98
Kuzitrin	568 (42)	0.12 (0.02)	-0.83 (0.10)	-0.99	-0.63	0.71

Snake Rivers in the vicinity of Nome, the Niukluk River which flows into the Fish River, accessed from the Council Road; and the Kuzitrin River which flows into the Pilgrim River, accessed from the Kougarok Road. Similiar $L\infty$ and K parameter estimates (Table 4, Figure 4), were observed for Arctic grayling sampled from the Kuzitrin and Pilgrim Rivers. Arctic grayling sampled from rivers in the other geographic areas did not demonstrate similiar growth characteristics (Table 4; Figures 5 and 6). A graphic comparison of age versus L_t among all Arctic grayling stocks examined in 1988 suggests that Arctic grayling from the Nome River achieve the greatest length per age class between four and 10 years (Figure 7). Arctic grayling from the Snake River had the greatest L_t among stocks at age 12.

A total of 30 Dolly Varden/Arctic char were incidentally captured or measured during angler interviews. Dolly Varden/Arctic char captured with a beach seine on the Snake River had the greatest mean FL (536 mm) of those sampled (Appendix Table 2).

Harvest Surveys

The total number of anglers interviewed was 32. Anglers were encountered on the Nome, Fish, Niukluk, Pilgrim, Eldorado, Fox, Solomon, and Sinuk Rivers. The majority of the interviews occurred on the Nome (28%) and Niukluk (25.%) Rivers (Table 5).

Total mean CPUE (fish per hour) for all streams was greatest for pink salmon *Oncorhynchus gorbuscha* (1.9) and Dolly Varden/Arctic char (1.7), followed by Arctic grayling (1.2), chum salmon *Oncorhynchus keta* (1.2) and silver salmon *Oncorhynchus kisutch* (0.6). Total mean HPUE for all streams was similiar to CPUE for all species except Arctic grayling. Total mean HPUE for Arctic grayling was 0.13, indicating that only a small portion of the Arctic grayling caught are actually harvested by anglers.

The demographic profile of anglers interviewed indicated that the majority were adult males residing in the vicinity of Nome, and their preferred sport fishing lures were spinners (Table 6).

The opinion of anglers regarding the quality of fishing in 1988 relative to previous years was mixed: 47% claimed it was the same, while 33% and 20% declared it to be worse and better, respectively (Table 7). A clear majority (65%) thought that the more restrictive regulations imposed in 1988 were a good idea in terms of the bag and possession limits; however, most disagreed with the size restriction. For example, anglers on the Pilgrim River indicated it was difficult to catch Arctic grayling less than 381 mm (15 in) in total length, as most fish hooked were larger. Nearly half (42%) of the anglers interviewed said they would only keep Arctic grayling between 457 and 584 mm (18 to 23 in) in total length (Table 7).

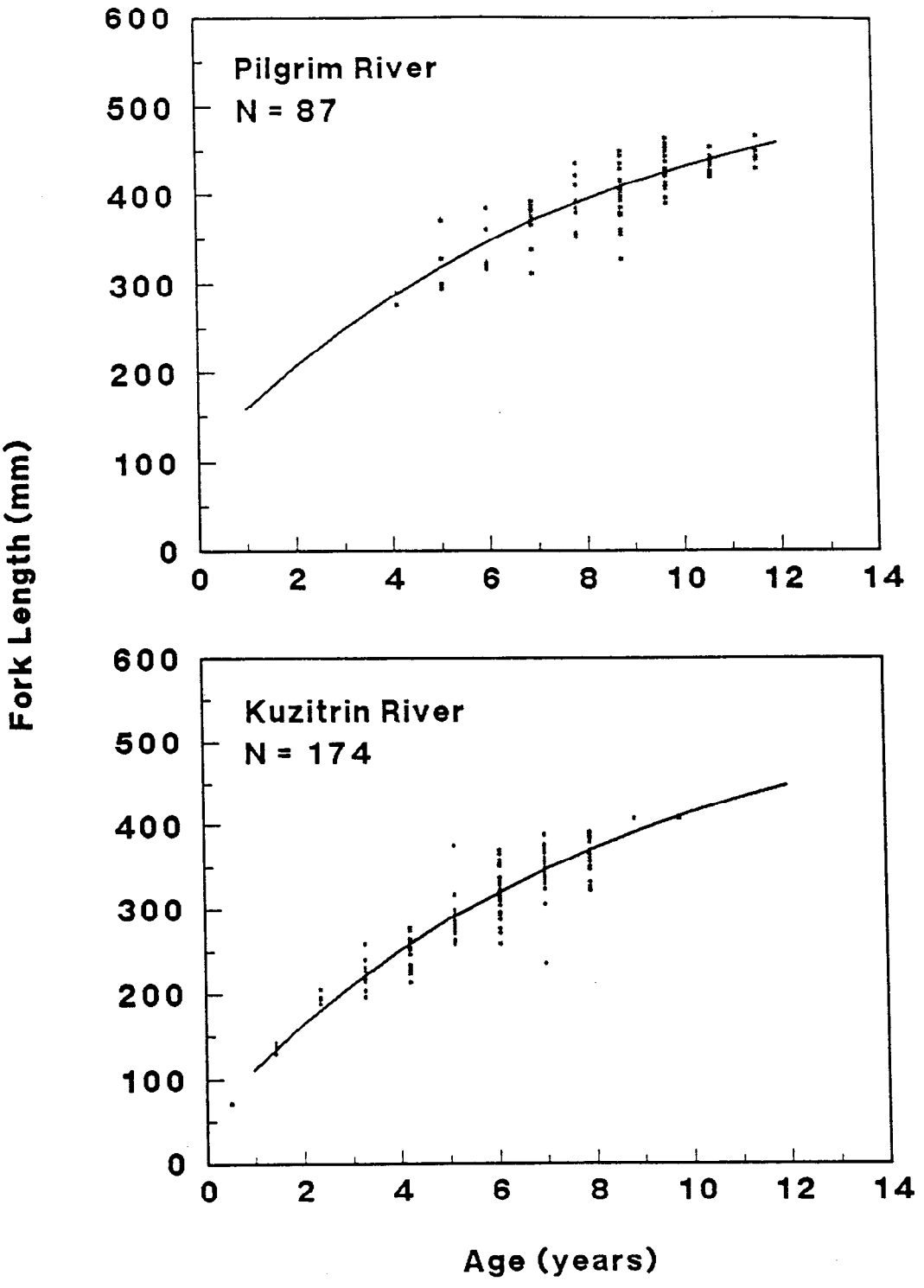

Figure 4. Growth curves of Arctic grayling from the Pilgrim and Kuzitrin Rivers, Seward Peninsula, 1988

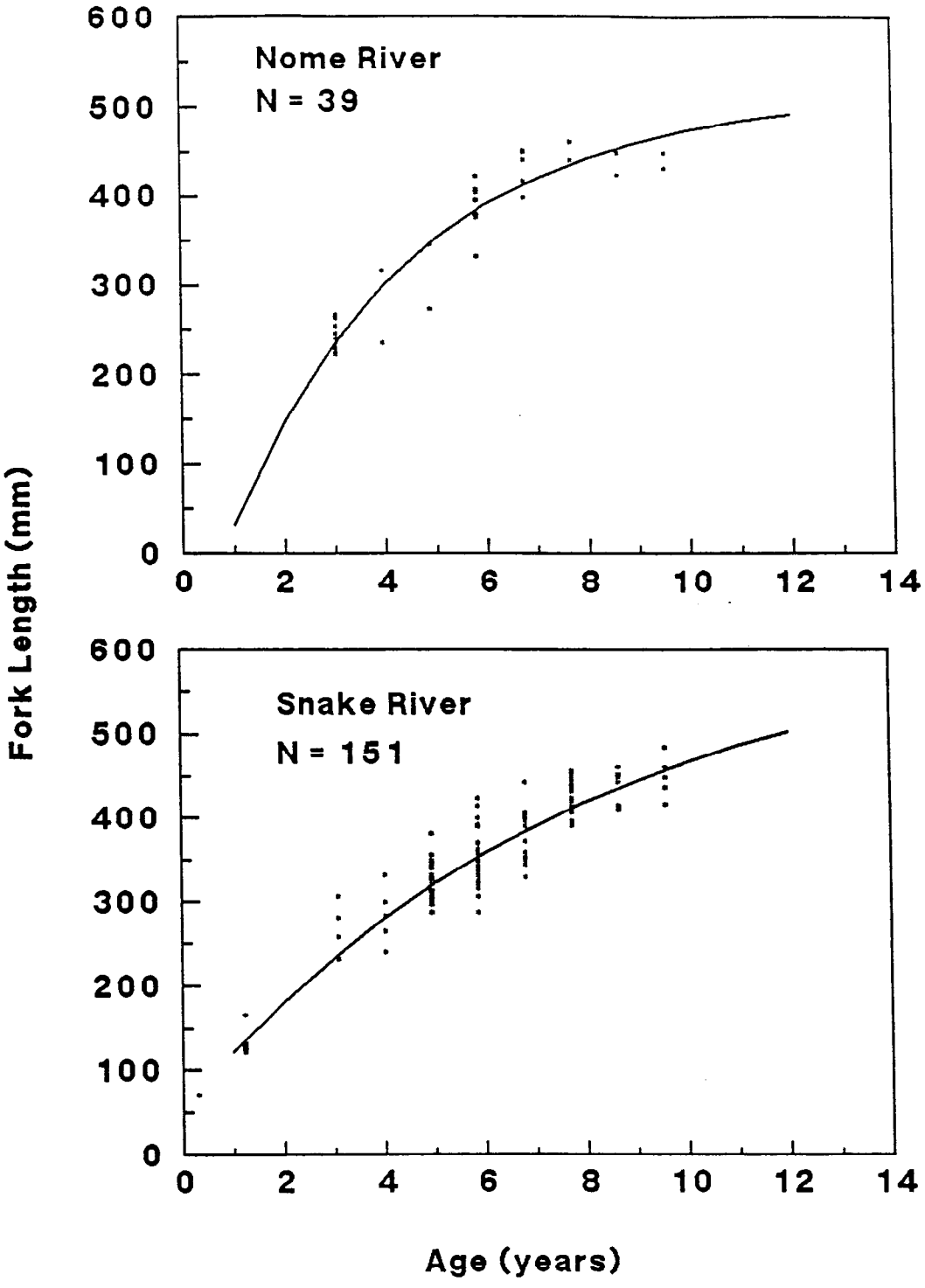

Figure 5. Growth curves of Arctic grayling from the Nome and Snake Rivers, Seward Peninsula, 1988

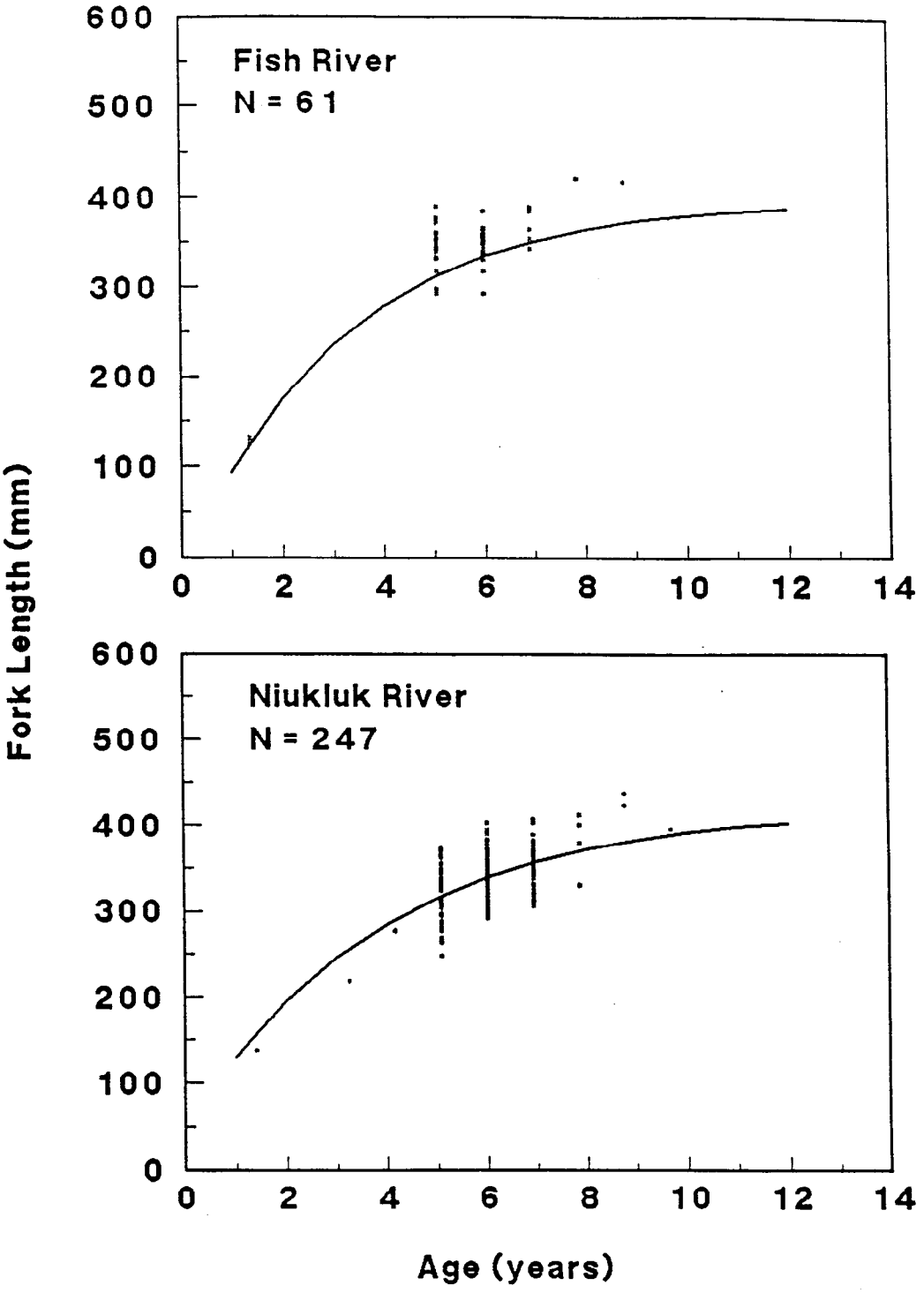

Figure 6. Growth curves of Arctic grayling from the Fish and Niukluk Rivers, Seward Peninsula, 1988

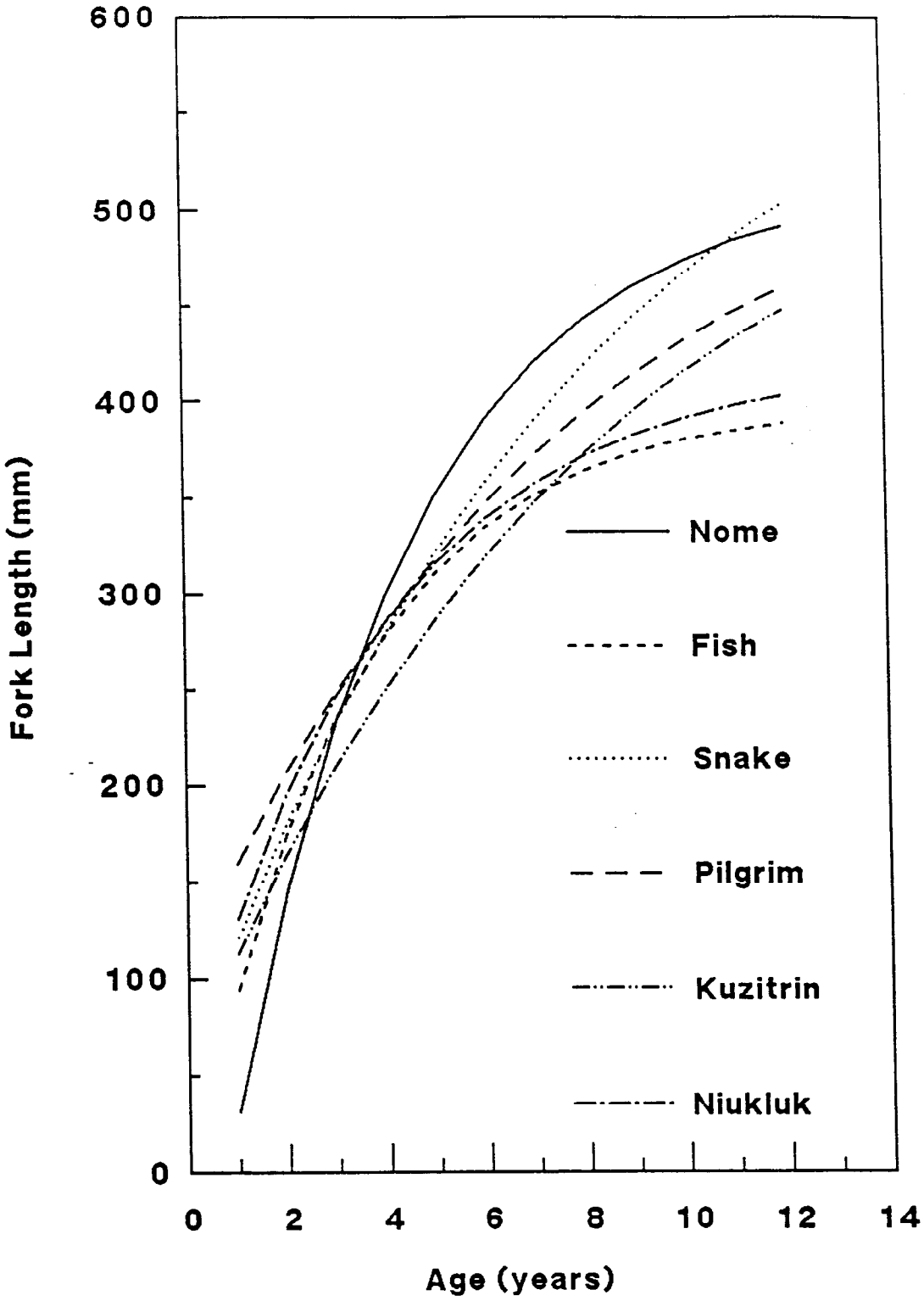

Figure 7. Comparison of growth curves of Arctic grayling from six rivers on the Seward Peninsula, 1988

Table 5. Number of anglers interviewed and estimates of CPUE (catch-per-hour), and HPUE (harvest-per-hour) for Seward Peninsula sport fisheries, Alaska, 1988.

Area	Angler Interviews[1]			CPUE[2]			HPUE[2]		
	Complete	Incomplete	Total	Mean	SE	CV	Mean	SE	CV
Nome River	3	6	9						
Arctic grayling	3	0	3	0.08	0.14	174%	0.08	0.14	174%
Dolly Varden	2	1	3	4.00	6.93	173%	4.00	6.93	173%
Chum salmon	0	3	3	0.44	0.77	173%	0.44	0.77	173%
Pink salmon	0	5	5	2.67	2.49	94%	2.13	2.02	95%
Fish River	0	1	1						
Dolly Varden	0	1	1	0.00	——	——	0.00	——	——
Coho salmon	0	1	1	2.00	——	——	2.00	——	——
Niukluk River	0	8	8						
Arctic grayling	0	6	6	3.13	5.00	160%	0.00	0.00	0%
Dolly Varden	0	2	2	2.00	1.41	71%	2.00	1.41	71%
Coho salmon	0	8	8	0.38	0.74	198%	0.38	0.74	198%
Pilgrim River	2	3	5						
Arctic grayling	2	2	4	0.48	0.22	46%	0.48	0.22	46%
Chum salmon	0	1	1	6.00	——	——	6.00	——	——
Dolly Varden	1	0	1	0.17	——	——	0.17	——	——
Eldorado River	1	0	1						
Arctic grayling	1	0	1	0.00	——	——	0.00	——	——
Fox River	0	3	3						
Arctic grayling	0	3	3	0.00	0.00	0%	0.00	0.00	0%
Solomon River	0	2	2						
Chum salmon	0	2	2	0.00	0.00	0%	0.00	0.00	0%
Pink salmon	0	2	2	0.00	0.00	0%	0.00	0.00	0%
Sinuk River	0	3	3						
Dolly Varden	0	3	3	0.33	0.29	87%	0.33	0.29	87%
Seward Penisula	6	26	32						

[1] Number of interviews next to each area are the total number of anglers interviewed in that area. However, the number of interviews next to each species is the anglers interviewed that were targeting each species. The number of anglers interviewed next to the species may exceed the total number of anglers interviewed in an area because the angler may target more than one species at a time.

[2] CPUE and HPUE were calculated from anglers that were targeting that particular species.

Table 6. Demographic profile of anglers interviewed, Seward Peninsula sport fisheries, Alaska, 1988.

Angler Characteristic	n[1]	%	SE	Angler Characteristic	n[1]	%	SE
Total Number of Interviews[2]	32	——	—	Local[3]	23	100%	0%
				Non-local	0	0%	0%
Male	27	84%	7%	Tourist	3	9%	5%
Female	5	16%	7%	Other	29	91%	5%
Adult	32	100%	0%	Gear Type:			
Youth	0	0%	0%	Spinners	23	77%	8%
				Bait	3	10%	6%
Resident	23	72%	8%	Flies	4	13%	6%
Non-Resident	9	28%	8%				
Military	0	0%	0%				

[1] Number of anglers in the categories will not always equal the total number of interviews because angler demographics were not marked down for all the anglers interviewed.

[2] Includes both complete- and incomplete-trip angler interviews combined.

[3] Local and non-local includes Alaska residents only. Local category includes anglers from the Seward Peninsula.

Table 7. Opinions of anglers interviewed at Seward Peninsula sport fisheries, Alaska, 1988.

Question	Opinion	n	%[1]	SE
1. How would you rate the fishing here this year for Arctic grayling?	Better	3	20%	11%
	Worse	5	33%	13%
	Same	7	47%	13%
	No Opinion	13	—	—
	Did not fish here last year	4	—	—
	Total	32		
2. The Board of Fisheries enacted new regulations to improve sport fishing for Arctic grayling in this area by decreasing the bag/possession limit to five Arctic grayling, of which only one can be over 15 inches.				
Do you think the new regulations are:	A Good Idea?	15	65%	10%
	Too Restrictive?	8	35%	10%
	Too liberal?	0	0%	0%
	Did not live here	0	—	—
	No Opinion	9	—	—
	Total	32		
3. What is the minimum sized Arctic grayling you would keep?	Any Size	0	0%	0%
	Over 6 Inches	2	11%	7%
	Over 10 Inches	4	21%	10%
	Over 15 Inches	5	26%	10%
	18 to 23 Inches Only	8	42%	12%
	No Opinion	12	—	—
	Total	31		

[1] Percentages are only calculated for Seward Peninsula area anglers with opinions. They do not take into account anglers in the no-opinion category or that do not live in the area.

DISCUSSION

Age and Length

The desired number (600) of fish to be sampled for length and age per stream was not achieved in 1988. However, the first objective of this study (to estimate mean length at age for Arctic grayling in a series of rivers) was attained for most age classes sampled. Estimates of mean lengths in some age classes were not as precise as desired, especially in the tails of the length frequency distributions. Younger age classes (ages 0 to 2 years) were under-represented for most stocks. This could be due to differential distribution of age classes and incomplete coverage of all possible rearing and feeding habitats in a river.

Another probable reason for under-representation of young age classes is gear selectivity. This study has shown significant selectivity for fish of varying lengths among a 1.3 cm (0.5 in) stretched mesh seine net and hook and line fishing. Ricker (1975) recommends a variety of sampling gear to obtain representative samples for all ages.

Some stocks, such as Arctic grayling from the Fish, and Niukluk Rivers, appeared to be primarily composed of one or two older age classes. Assuming river coverage and method of capture were adequate for representative sampling of older age classes, it appears the sport and subsistence fisheries for Arctic grayling in these rivers are being supported by only a few strong cohorts. Holmes (1985) reported that Arctic grayling in runoff streams of the Tanana drainage tend to have one or two strong year classes that support most of the fishing pressure. This reliance on periodic strong year classes makes these stocks much more vulnerable to exploitation.

Sufficient age and length data were collected in 1988 to generate growth parameter estimates and to compare growth characteristics among stocks. This study demonstrated that growth characteristics vary among Arctic grayling stocks on the Seward Peninsula, similiar to findings by Clark (1989) for Arctic grayling stocks in the Tanana River drainage.

Maximum length (L_∞) estimates of four Arctic grayling stocks from the Seward Peninsula were greater than estimates of stocks from either the Salcha or Chatanika Rivers (489 mm, SE = 19; 375 mm, SE = 11, respectively). Estimated K was greater for three stocks on the Seward Peninsula compared to estimates of K for fish from the Salcha and Chatanika Rivers ($K = 0.16$, $SE = 0.02$; $K = 0.19$, $SE = 0.02$, respectively; from Clark 1989). Continued collection of growth information for Arctic grayling on the Seward Peninsula, in addition to initiation of abundance and other population dynamics estimates, will identify sustainable levels of harvest for specific stocks.

Harvest Surveys

This study was initiated in part because past studies on the Seward Peninsula (Alt 1978, 1979, 1980) and the Statewide Harvest Survey (Mills 1987, 1988) indicated substantial catches of Arctic grayling were taking place from some of these streams. The number of angler interviews conducted in 1988 was

insufficient to achieve the second objective of this study: to estimate Arctic grayling and Dolly Varden/Arctic char CPUE within 10% of the true value 90% of the time. One probable reason relates to the method by which anglers were contacted. Harvest survey strategy in 1988 was to interview those anglers encountered while conducting age and length sampling; anglers were not deliberately sought. Because the sport fishery for Arctic grayling occurs on a number of rivers spread across a wide geographic area, it is not deemed cost-effective to launch a creel census program for every Arctic grayling stream on the Seward Peninsula. It may be feasible to seek angler interviews for a particular stream with identified conservation concerns by public responses to postal harvest surveys.

Angler interviews in 1988 provided information on harvest strategy of Arctic grayling by sport and subsistence fishermen. Most local anglers interviewed stated they released Arctic grayling less than 381 mm (15 in) in length, even prior to implementation of new regulations in 1988. Operators of a sport fishing lodge indicated their clients (generally non-resident) also caught and released Arctic grayling, and generally harvested only those greater than 457 to 508 mm (18 to 20 in) in length. Most sport anglers implicated the subsistence fishery as harvesting the greatest number of Arctic grayling, both as a target species and incidental to harvest of other species including salmon. A subsistence fisherman interviewed claimed a harvest of 200 to 300 Arctic grayling per year. Lack of enforcement of existing regulations regarding sport and subsistence take of Arctic grayling was also implicated as a conservation concern by those interviewed.

Long-term goals of this project include the identification of Arctic grayling stocks capable of producing trophy fisheries or large sustained yields, and development of regulations to insure continued sustained yields from the fisheries for Arctic grayling. To achieve these goals, data on population abundance and growth and age structure per stream must be acquired over several years. Issues such as subsistence harvest of Arctic grayling and enforcement of existing regulations need to be studied and resolved.

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APPENDIX TABLES

Appendix Table 1. List of tag numbers and beach seine sets by date and stream for Arctic grayling and Dolly Varden/Arctic char sampled on the Seward Peninsula, 1988.

Stream	Dates	Total	Tags Nos.	Removed	Beach Seine No. Sets	Beach Seine CPUE
Arctic grayling						
Nome	2-9 July	40	90,000-90,004 90,007-90,014 90,016-90,033 90,116-90,117 90,119-90,125	90,031[1]	34	1.6
Pilgrim	12-27 July	94	90,127-90,128 90,130-90,131 90,176-90,178 90,180-90,258	90,211[1] 90,199[1]	24	3.4
Snake	8-25 July	119	90,036 90,038 90,040-90,070 90,072-90,082 90,085-90,099 90,101-90,115 90,132-90,136 90,138-90,152 90,154-90,155 90,158-90,167 90,171-90,175 90,351-90,353 90,356-90,360		19	7.5
Fish	28 July	63	90,340-90,349 90,400-90,438 90,440-90,453		15	4.2
Sinuk	20 July	2	90,168-90,169		5	0
Boston	26-27 July	78	90,300-90,339 90,361-90,376 90,378-90,399		16	4.8
Kuzitrin	3-4 August	157	90,259-90,287 90,289-90,299 90,900-90,948 90,950-90,964 90,966-91,018	90,956[2] 90,964[2]	16	4.6

-continued-

Appendix Table 1. List of tag numbers and beach seine sets by date and stream for Arctic grayling and Dolly Varden/Arctic char sampled on the Seward Peninsula, 1988 (continued).

Stream	Dates	Total	Tags Nos.	Removed	Beach Seine No. Sets	Beach Seine CPUE[3]
Niukluk	29 July-10 August	280	90,454-90,479 90,481-90,518 91,072-91,076 91,078-91,097 91,099-91,105 91,107-91,109 91,111-91,125 91,130-91,137 91,139-91,169 91,171-91,240 91,242-91,251 91,991-91,995 91,950-91,962 91,964-91,990 91,997-91,999	91,182[2]	21	8.5
Solomon	10 July	1	90,126		4	0.3
Eldorado	5-6 August	53	91,019-91,071	90,092[1]	1	0
Dolly Varden/Arctic char						
Nome	6-9 July	4	90,005-90,006 90,015 90,118		34	0.1
Snake	8-25 July	6	90,034-90,035 90,037 90,039 90,083-90,084		19	0.3
Sinuk	20 July	1	90,170		5	0
Boston	26-27 July	1	90,377		16	0.1
Niukluk	29 July-10 August	11	91,077 91,098 91,110 91,126-91,129 91,170 91,196 91,963 91,993		21	0.5

[1] Tag numbers reported harvested as of 15 February, 1989.
[2] Mortality during sampling.

Appendix Table 2. Length (mm) statistics for Dolly Varden Arctic char incidentally captured, by river, Seward Peninsula, 1988.

		Sampling Gear						
		Hook and Line				Beach Seine		
River	Date	No.	Range	Mean	SE	No.	Range	Mean	SE
Snake	8 July	0				6	356-800	536	56
Sinuk	21 July	1	--	400	--	0			
Niukluk	8-10 July	5[1]	400-435	418	6	10	305-495	407	18
Nome	6-9 July	3[1]	433-480	458	11	4	409-480	455	14
Boston	27 July	0				1	--	420	--

[1] Includes samples obtained from angler interviews.